Thesis/
Reports
Markin,
G. P.

Final Report
00-CO-11222022-576

BIOLOGICAL CONTROL OF TANSY RAGWORT IN MONTANA
Status of Work as of December 2001

Compiled by G.P. Markin and J.L. Birdsall
USFS Rocky Mountain Research Station
1648 South 7th Avenue
Bozeman, MT 59717

RMRS Library
USDA Forest Service
SEP 17 2007
240 W Prospect Rd
Fort Collins CO 80526

TABLE OF CONTENTS

BIOLOGICAL CONTROL OF TANSY RAGWORT IN MONTANA
Status of Work as of December 2001

EXECUTIVE SUMMARY	i
INTRODUCTION	1
SUPPORTING WORK	2
Redistribution of Biocontrol Agents (Travis Dubyak)	2
Phenology of Tansy Ragwort in Montana (Meghan Trainor)	3
Meteorology of Study Sites	5
BIOLOGICAL CONTROL	6
Status of the Cinnabar Moth (*Tyria jacobaeae*)	6
Flathead County	6
Lincoln County – Little Wolf Creek Area	6
Island Lake Area	6
Health of the Cinnabar Moth Population	7
Attack on Non-Target Plants	8
Status of the Seedhead Fly (*Botanophila seneciella*)	8
Status of the Tansy Ragwort Flea Beetle (*Longitarsus jacobaeae*)	10
Swiss Strain of Flea Beetle (Ken Puliafico)	11
PLANNED 2002 WORK	12
ACKNOWLEDGEMENTS	12

COVER: Little Wolf Creek burn area in Lincoln County with cage containing tansy ragwort fleabeetles.

EXECUTIVE SUMMARY

Efforts to control the weed tansy ragwort in northwestern Montana by introducing a complex of its natural enemies have now entered the fifth year. In 2001, we continued monitoring the establishment of the three introduced biological control agents and redistributing them to new areas. However, work also continued on our efforts to understand the invasiveness of tansy in northwestern Montana and to determine the impact of the agents. While all three agents are now established, they appear to be giving us varying degrees of success.

Of the three insects we have introduced, the cinnabar moth in Flathead County appears to be the most effective. Populations have built up around the initial release sites to levels where the moths are completely defoliating all plants on ¼ to 10 acre plots and are naturally dispersing throughout the remaining tansy infestation. If this population remains healthy and continues its present rate of increase, we are predicting this moth will give us effective control of tansy in Flathead County within a few more years. The release of this insect in Lincoln County began several years later than in Flathead County but we have now confirmed that it is established, at least in the Little Wolf Creek drainage. Since the habitat in this open and previously burned area is very similar to Flathead County, we expect this population will also continue to increase and eventually provide effective control. Unfortunately, our attempts to establish this agent around Island Lake where tansy grows in unburned, heavily grazed timberlands have not been successful.

The second introduced insect, the seedhead fly, has naturally dispersed through the entire tansy infestation in Lincoln and Flathead Counties but its rate of increase of only one or two percent a year continues to be much slower than expected. Preliminary studies indicate that this insect is not well synchronized with the plant in Montana since it attacks only the first flush of new flower buds at the beginning of the flowering season. Fly populations may also be adversely impacted in the future as the cinnabar moth populations continue to increase and destroy the flower buds that the flies require.

The third introduced insect, the tansy ragwort flea beetle, is now confirmed to be established in Montana but only at very low populations and only at a few of the sites where we released it four to five years ago. We have now concluded that the Oregon strain of this insect will not be an effective agent in Montana since it is very poorly synchronized to our climate. However, our efforts to find a new cold hardy strain in Switzerland have been very productive. A colony of the Swiss strain is in quarantine in Bozeman, although at least another season of study and testing may be necessary before we are ready to ask for a permit to release it in the field.

Fig 1. Typical tansy ragwort infestation. Photo by Eric Coombs, Oregon Department of Agriculture.

INTRODUCTION

The poisonous European weed tansy ragwort (*Senecio jacobaea*) (Fig. 1) was accidentally introduced into northwestern Montana sometime before 1990. The present infestation was detected in 1996 in Flathead County west of Whitefish, Montana, where tansy was found widely scattered on lands burned by the1994 Little Wolf wildfire. Initially the plant was thought to infest only a few hundred acres, making the infestation small enough to contain and hopefully eradicate with conventional herbicide treatments. However, subsequent surveys soon indicated that the infestation was larger than first believed, with the main populations extending well beyond the fire area, particularly west into Lincoln County. Also, several hundred small, isolated satellite populations were found up to 50 miles away. At present, eradication is probably impossible and management has shifted to a program of: (1) intensive surveys of the outlying areas to locate satellite populations that can be eradicated; (2) creation of a containment zone in and around the fire area being managed to reduce tansy populations to prevent seed spread out of this core area; and (3) a program of biological control – a long-term solution involving the introduction and establishment of a complex of natural enemies that will reduce the tansy population to a minor but acceptable component of our local ecosystem.

To establish the biological control program, three biocontrol agents from Oregon were released beginning in 1997. The three insects were originally introduced to the West Coast approximately 30 years earlier from Italy and southern France and are credited with controlling this plant in the warmer, western portions of Oregon, Washington, and northern California. Initially, their release in Montana was considered experimental since earlier attempts by the Oregon Department of Agriculture to introduce them to eastern Oregon had failed. The consensus was that because the insects originated from a Mediterranean-type climate, they were not pre-adapted to the longer, colder winters of the Interior Northwest. However, our monitoring indicates that all three agents are now established and that two appear to be doing well.

In 1999, we shifted our program to redistribution of the two successful agents throughout the main infestation of tansy in Flathead County and expanded the program westward into Lincoln County, particularly into the head of Little Wolf Creek which had also been burned in the 1994 wildfire. In this large area of burned land, we found tansy to be even more abundant than in Flathead County. However, because of the mixed ownership and large area infested, efforts at chemical control lagged behind Flathead County, giving us a much larger and denser stand of tansy to target for biocontrol. In 2000, we shifted our emphasis from Flathead to Lincoln County and set up our center of operation at Cow Camp, a summer ranch privately owned by Terry Prongaie of Hot Springs, Montana, who holds grazing rights on the surrounding Plum Creek lands. Operating out of Cow Camp allowed us much closer access to the burned area at the head of Little Wolf Creek where we could concentrate our new effort to establish the agents.

Working out of Cow Camp also gave us access south to the area around Island Lake. By 2000, we realized that the largest area infested with tansy in Montana probably now lies within this Island Lake area, outside the 1994 Little Wolf burn. Tansy in this area is particularly challenging to control due to a number of factors. Since much of this area is being managed for timber production, it contains a major network of forest roads which allows rapid spread of tansy. Also, extensive soil disturbance from the logging operations and slash disposal creates ideal seedbeds

for tansy. The problem is compounded by heavy grazing which removes the competing vegetation and enables the poisonous tansy to grow with minimal competition.

In 2001 (the period covered by this report), we concentrated our efforts on redistribution of biocontrol agents in the burned area at the head of Little Wolf Creek and the unburned Plum Creek and Forest Service Lands around Island Lake and on research to determine if tansy biocontrol is feasible in unburned timberlands.

SUPPORTING WORK

Redistribution of Biocontrol Agents (Travis Dubyak)

Within the original target area in Flathead County (outlined in Fig. 2), the cinnabar moth has become well established and has begun to naturally disperse from our original release sites. During 2001, ten additional moth releases were made on outlying tansy populations within this area or at sites where the moth had previously been released but not yet recovered. These releases consisted of larvae collected from Site 6 and were coordinated by Terry Carter of Flathead National Forest. In addition, larvae from Sites 1, 4, and Cross Rock Fire Sign were redistributed to tansy plants bordering the original release points. This was done because the larvae were in such high concentrations within the centers of these sites that they were in danger of exhausting their food supplies.

During 2001, we also concentrated on continuing to release the cinnabar moth throughout the tansy infestation in Lincoln County (outlined in Fig. 2). Table 1 lists the operational releases made in this area. These releases consisted of larvae and eggs and were supervised by Bill Chalgren, the Tansy Coordinator. Research personnel will revisit these sites over the next few years to confirm that establishment has occurred, but the objective of these operational releases is to establish nursery sites scattered throughout the Lincoln County tansy infestation from which the insects can naturally disperse into the surrounding areas. Vegetation managers can also use these sites in the future to collect insects for redistribution to additional sites.

No seedhead fly releases were necessary in Flathead or Lincoln County in 2001 as the fly has naturally dispersed throughout the entire tansy infestation area. One new fleabeetle release was made which consisted of 200 adults brought from plants near Mt. Hood in Oregon and placed in a cage in the Little Wolf Creek area (Cover and Figure 10).

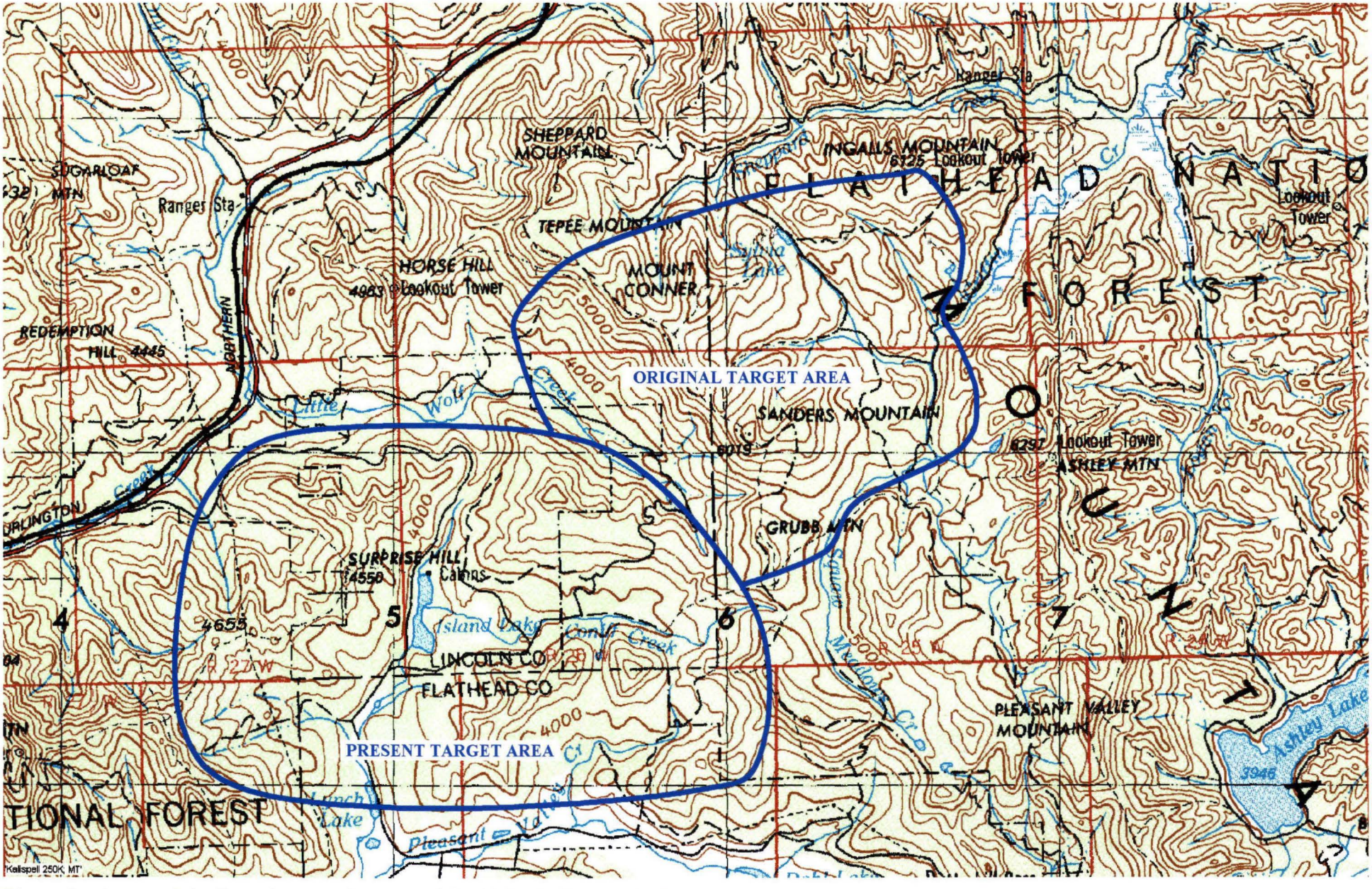


Figure 2. Areas originally and presently targeted for biological control of tansy ragwort.

Table 1. Locations of the operational release sites of the cinnabar moth made during the summer of 2001 in Lincoln County.

Date	Site	No. and Stage
7/19/2001	Tensaw	300 Larvae
7/19/2001	Railroad Grade #1	150 Larvae 200 Eggs
7/19/2001	Railroad Grade #2	150 Larvae 200 Eggs
7/19/2001	Lost Prairie #1	300 Larvae 55 Eggs
7/19/2001	Lost Prairie #2	300 Larvae
7/19/2001	Lost Prairie Creekbed	300 Larvae
7/19/2001	N. Surprise Hill	200 Larvae 200 Eggs
7/19/2001	Dan DeJong's #1	600 Larvae 500 Eggs
7/19/2001	Dan DeJong's #2	300 Larvae
7/19/2001	Dan DeJong's #3	300 Larvae
7/19/2001	Dan DeJong's #4	300 Larvae 100 Eggs
7/19/2001	Coniff Creek #1	300 Larvae 100 Eggs
7/19/2001	Coniff Creek #2	500 Larvae
7/19/2001	Coniff Creek #3	600 Larvae
7/26/2001	Sinclair Road End*	75 Larvae
8/01/2001	Island Lake*	1000 Larvae
8/01/2001	Dan DeJong's Stump*	1000 Larvae
8/01/2001	Plum Creek Landing*	1000 Larvae
8/07/2001	N. of Island Lake Across Fence	300 Larvae
8/07/2001	N. of Island Lake Plant Collection Site	300 Larvae
8/09/2001	Near Plum Creek Landing*	300 Larvae
8/09/2001	Skidder Trail Past Cow Camp Turnoff #1	300 Larvae
8/09/2001	Skidder Trail Past Cow Camp Turnoff #2	300 Larvae
8/09/2001	Near S. Surprise Hill	300 Larvae
8/09/2001	No Bear Road Site*	300 Larvae

*Rerelease at previously failed site.

Phenology of Tansy Ragwort in Montana (Meghan Trainor)

In 2001, tansy phenology studies were conducted by Meghan A. Trainor, a graduate research assistant supervised by Dr. Bruce Maxwell, Montana State University - Bozeman. Meghan wrote the following summary of her program.

In order to develop ecologically based management strategies to reduce the spread and potential impact of tansy ragwort, it is important to first identify the biotic and abiotic factors that influence tansy ragwort colonization and establishment. We will then use this information to construct a life history model for tansy ragwort and identify the environmental conditions where tansy ragwort may be the most invasive and thus require management priority. The environmental conditions under which we are examining tansy ragwort population dynamics include: 1) areas

burned by wildfire, 2) areas burned and logged, and 3) areas not disturbed by wildfire or logging. To collect the needed data, four separate studies are underway.

1. Phenology (life history) of tansy in burned and unburned habitats. To quantify tansy ragwort seedling survival, mature plant survival, vegetative reproduction and seed production rates, we selected ten areas in which to install permanent sampling plots in the Little Wolf Creek area in June 2001. Each area corresponds to a different environment type (burned, not burned, burned and logged). I installed 10 $1m^2$ plots in each area for a total of 95 $1m^2$ plots (one area has 5 plots). I mapped each individual tansy ragwort plant within each plot twice during the summer, once in late June-early July and once in late August. Flower heads were clipped in late August from a random sample of flowering plants, bagged, and brought to Bozeman. The seeds produced by each plant were counted. Mapping each plant and recording its life history stage (seedling, rosette, bolted not flowering, flowering, seeding) will allow us to construct a life history model.

2. Germination and growth of tansy in burned and unburned soil-field study. Fire appears to play a major role in the invasion of tansy ragwort in Montana. To study the relationship between fire and tansy ragwort seedling establishment, in mid-October 2001, fire was prescribed to six total plots in the unburned-forested area (Fig. 3). Three burns simulated high-intensity burns and three burns simulated low-intensity burns. Thermocouples attached to a data logger were buried beneath one of the high intensity burns to record surface, duff, and soil temperatures (Fig. 4). One day later, 400 tansy ragwort seeds were planted into each of the six burned plots (Fig. 5). Three unburned plots were also seeded. Emerging tansy ragwort plants in these areas will be counted beginning in June 2002.

3. Germination and growth of tansy ragwort in burned and unburned forest soil-laboratory study. To quantify the effects of environment on tansy ragwort seed germination, tansy ragwort seeds were collected in August and brought to Bozeman. Initial germination tests show the seed samples to have an average germination rate of 70%. The effects of dry heat, wet heat, and charred wood on the tansy ragwort seed germination will be tested in a greenhouse experiment. Litter from each study area was collected in August and brought back to Bozeman. Pasteurized soil has been spread in 32 steel flats in the greenhouse. Litter will be burned and then spread on top of the soil in each flat and 200 tansy seeds planted.

4. Tansy seed life when buried in burned and unburned soil. The effects of environment on tansy ragwort seed survival rate in soil in the field is being studied. Tansy ragwort seed collected from the Kootenai Forest during the summer 2001 was brought back to Bozeman and counted. Two hundred seeds were placed in each of 60 nylon mesh bags. In late September 2001, six bags were buried at each study area near Little Wolf Mountain. Each bag was buried 2 cm below the soil surface. Two bags will be unearthed each year in July 2002, 2003, and 2004. Once unearthed, the contents of each bag will be placed 1 cm deep in soil-filled pots to allow germination to occur and then placed in an ideal germination environment in a growth chamber. Tansy ragwort seedlings will be counted for 6 weeks to determine the number of viable seeds.

Fig. 3. Prescribed burning in Lincoln County to study tansy seed germination in high intensity, low intensity, and unburned plots.

Fig. 4. Thermocouples buried beneath a high intensity burn plot to record surface, duff, and soil temperatures.

Fig. 5. Tansy seeds planted in a burned plot and covered with screen to protect from rodents.

Meteorology of Study Sites

2000 and 2001 were drought years in Montana. While the total summer rainfall for the years 1997-1999 averaged about 10 inches, for the years 2000 and 2001 total summer rainfall averaged only about 6 inches (Fig. 6). Total summer rainfall in 2001 was similar for both the Flathead and Lincoln County sites with a total of 6.5 inches at Site 1 in Flathead County and 5.7 inches at Island Lake in Lincoln County. In the five years that we have been measuring weather conditions at our research sites in Flathead County, the area consistently becomes snow free by mid-April and remains open until mid-October to mid-November (Fig. 7). This insulating winter snow pack may be a major factor contributing to the survival of the insects in Montana as it protects them from exposure to extreme cold winter temperatures.

Figure 6. Cumulative rainfall for each of five years at a tansy research site in Flathead County. Rain gage was set up July 3, 1997, and the 4.25 in. of rain for the first two months in 1997 is an estimate.

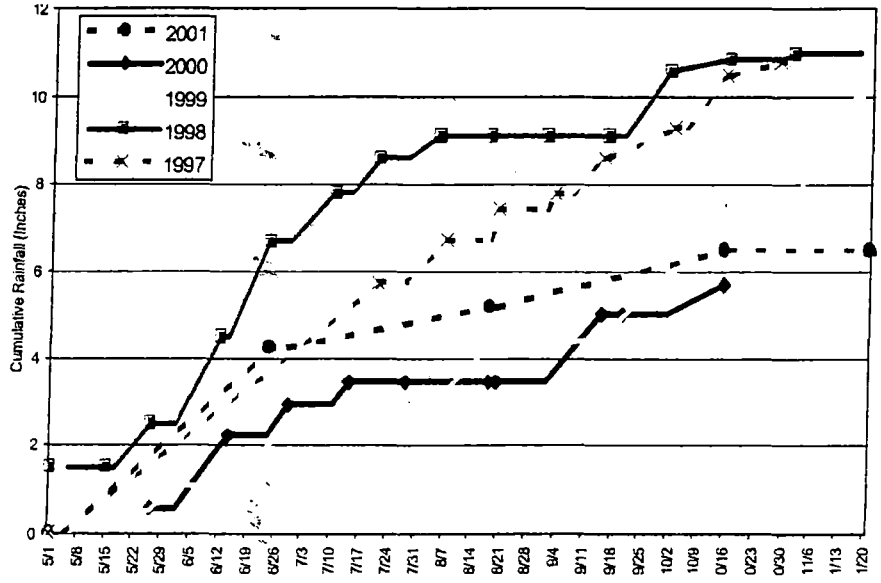
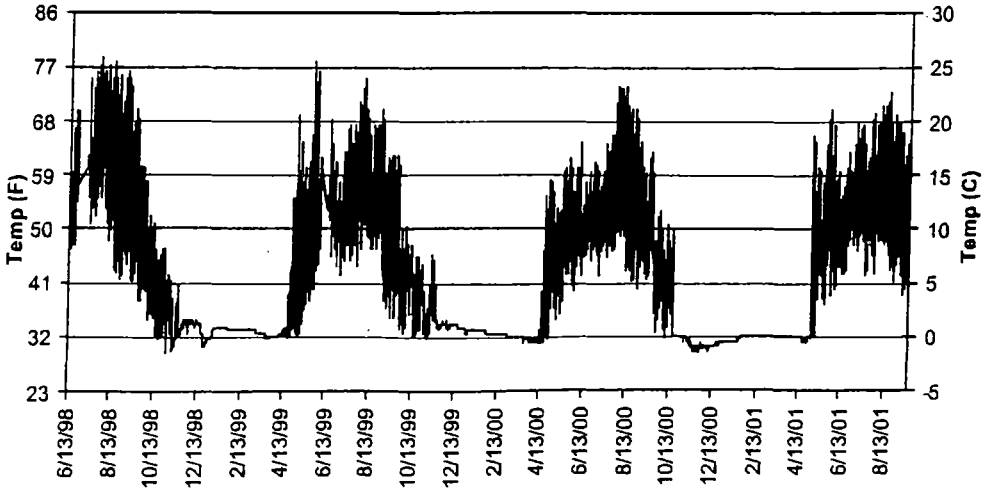


Figure 7. Soil temperatures in the tansy ragwort root zone from Site 1 in Flathead County. Relatively flat line from November to April indicates snow cover insulating the ground.



BIOLGICAL CONTROL

Status of the Cinnabar Moth (*Tyria jacobaeae*)

Flathead County

Population monitoring. The original populations of this moth released in 1997-1999 within the Little Wolf Burn area have continued to do excellently. Of the ten releases that we intensively monitor, all have well established moth populations. In 2001, five of these had such high larval populations that the tansy on ¼ to over 10 acre blocks was completely defoliated. In the impacted areas, the feeding is so complete that no flowers are formed since the larvae completely defoliate all mature plants then move to the ground where they feed on and destroy the rosettes and even small seedlings. Mature tansy plants when heavily fed on by cinnabar moths did not die, but went into winter in an exceptionally weakened state, which we hope results in poor overwintering survival. In Oregon, the cinnabar moth is felt to be ineffective because after it has completed feeding, the long, warm and wet fall allows the plants to recover and put out a second flush of flowers and seeds. In Montana, cinnabar moth feeding ends in August, but the droughts of the last two years extended into September and early October and the lack of fall rains prevented the plants from regrowing and producing secondary flowers.

We are now finding significant numbers of naturally dispersed moths up to one mile away from their original release sites and all new pockets of tansy that we could find in the core burned area in 2001 had already been colonized by the moth. It is our conclusion that the Little Wolf fire area on Flathead County side is now saturated with moths and further redistribution will probably not be necessary except on isolated tansy patches two or more miles from the present core area.

Lincoln County – Little Wolf Creek Area

Releases of the cinnabar moth in the Little Wolf Creek burn area of Lincoln County began in 1999, two years after we began releasing in Flathead County. Accordingly, these populations are much younger. However, in 2001 at least five of the ten sites at which moths were released in 1999 and 2000 were found to have small but well established populations. Since this area is almost identical in elevation, winter temperatures, and snow pack to the original targeted area in Flathead County, we predict that the cinnabar moth in this area will be as abundant as it is in Flathead County within two years. Our goal has been to make at least one release per square mile throughout the entire Little Wolf burn, which will require some additional releases in Lincoln County.

Island Lake Area

This area straddles the Lincoln County/Flathead County line and has more mixed ownership of land than the areas in which we have previously worked. Unlike our other areas, this area is unburned although it suffers heavy disturbance from extensive logging, cattle grazing, recreation use and firewood collecting. We began working here intensively in 2000 and have concluded that this area is larger and contains more tansy than the entire Little Wolf burn area. Since we now have successful establishment of the cinnabar moth on the Flathead side of the divide and in the upper end of the Little Wolf drainage on the Lincoln side, much of our research effort in the

future will be devoted to working in the Island Lake area. This area is representative of the typical unburned forested terrain of Western Montana in which tansy can be expected to be found in the future. If the cinnabar moth is the biocontrol agent on which we will depend in the future, we need to know more about its survival and biology in this type of terrain.

Five releases of cinnabar moths were made in this area in 1999 and an additional five in 2000. However, when compared to the areas burned in the Little Wolf fire, this new habitat does not seem to be as favorable for the cinnabar moth. To date, we have identified only one established moth population within this area. Our failure to recover the moth for two years after the initial release leads us to suspect that this new, unburned habitat may not be as suitable for the moth as the burned area. Temperatures recorded on our soil probes indicate there are no significant differences between the climate in this area and the Little Wolf burn and the snow pack which protects the pupae during overwintering is similar. One possible explanation for the moth's failure to establish may be the heavy grazing in this area. Perhaps the hooves of the cattle are destroying significant numbers of pupae, which bury themselves in the upper inch of the soil. Next year, we plan to make additional releases if we can locate areas that are lightly grazed or if we can obtain the funding and landowner cooperation necessary to fence areas to exclude cattle.

Health of the Cinnabar Moth Population

The initial release of the cinnabar moth in 1997 was from an Oregon population which unbeknownst to us was contaminated with two diseases. Since 1998, we have initiated a screening program to eliminate these diseases in all subsequent releases and are monitoring all our populations for disease incidence. Accordingly, in 2001, we collected at least fifteen large larvae from each of our early releases and checked them for pathogens and parasites. The virus, which is our biggest worry, is still present but at only one site and at such low levels that it is probably not impacting the moth populations. However, the second disease (a microsporidium) is showing up more commonly in the early-released populations and for the first time we observed mortality in field collected larvae brought to our Bozeman laboratory. Although neither disease appears to be significantly affecting the populations in the field, their presence strongly indicates the need for careful selection of an insect population to be used for redistribution. Populations targeted for redistribution to new areas should be thoroughly sampled to verify that they are disease free.

As populations of cinnabar moths increase we are also finding evidence of parasitism, but so far only of the eggs. Collection and examination of egg masses after the larvae have emerged indicates that overall 17.7% (512 parasitazed out of 2887) of the eggs examined had been attacked in 2001. In 2000, only 7% (72 parasitized out of 1024 eggs) of the examined eggs were parasitized. The occurrence of the egg parasite was expected. It is probably a Trichograma, a group of common Montana insects that attack the eggs of most moths and butterflies. As the cinnabar moths become more abundant it can be expected that a percentage of their eggs will become attacked. Similar attack has been observed on the cinnabar moth in Oregon and has not been associated with any adverse effect on the population. We expect the cinnabar moth will continue to thrive despite the presence of this egg parasite. Fortunately, to date, we have found no positive evidence of parasite attack of either larvae or pupae. Although we occasionally find

parasite eggs on moth larvae in the field, the cinnabar moth appears to be an unfavorable host on which this parasite cannot survive.

Attack on Non-Target Plants

As our cinnabar moth population continues to increase, we are paying particular attention to the possibility that starving larvae, when they run out of tansy plants, might begin to feed on the adjacent native *Senecio* species. In the laboratory, cinnabar moths can be forced to feed on the leaves of all four native *Senecio* species found in the tansy area. We are now watching intensely to see whether similar feeding might occur in the field. In 2001, despite high numbers of cinnabar moths and heavy feeding on tansy at many of our research sites, there was very little feeding on adjacent *Packera pseudaurea* (syn. *Senecio pseudaureus*), *Senecio hydrophilus*, *Senecio triangularis*, or *Senecio integerrimus* plants. The feeding damage that did occur consisted of small bites on the leaves that did not adversely affect flowering or seeding of the native plant species. In addition, few larvae were found at Site 5 in Flathead County. We have been closely monitoring this site since fall herbicide spraying in 1999 killed the tansy plants but left the *Packera pseudaurea* plants uninjured. In 2000, the cinnabar moth population remained high, feeding extensively on the *P. pseudaurea* and reducing their seed set. However, in 2001, the cinnabar moth population was dramatically reduced indicating that in the absence of tansy, *P. pseudaurea* will not sustain the moth population. In addition, by 2001, the perennial *P. pseudaurea* plants appeared to have recovered from the previous year's attack. Because *P. pseudaurea* was the species we were most concerned about based on our laboratory feeding trials, we now believe that the *Senecio* species in our research area will not incur sustained and significant damage even at higher cinnabar moth population levels.

Status of the Seedhead Fly (*Botanophila seneciella*)

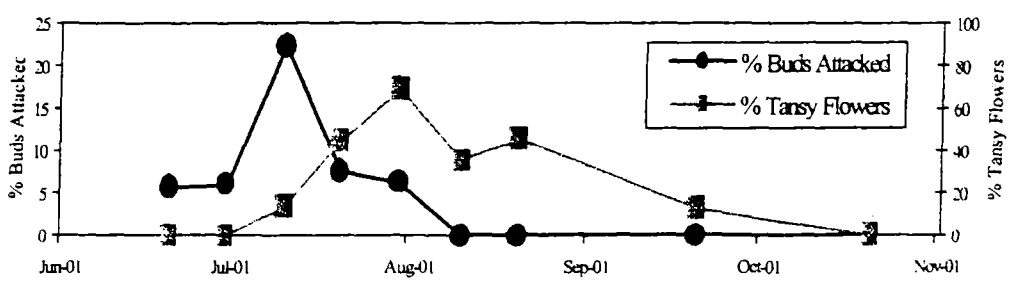
Sampling for the seedhead flies was complicated in 2001 because most of our original seedhead fly study sites located on the Flathead side of the Little Wolf burn were lost when the cinnabar moths totally stripped the tansy plants. This forced us to locate new collection sites. On the Flathead County side, there was only a 2% increase in seedheads attacked from 5.82% in 2000 to 7.82% in 2001 (Table 2). On the Lincoln County side where seedhead flies were released two years later, seedhead attack increased from 1.87% in 2000 to 2.38% in 2001. It was encouraging that on the Lincoln County side the seedhead fly was found on every patch of tansy we examined, even those isolated by many miles from other known stands. The seedhead fly also appears to have excellent natural dispersal in areas that are heavily timbered. Monitoring of the seedhead fly shows that the populations remain relatively healthy. No signs of disease have been observed although we found at least one fly larva still within the seedhead that was attacked by a wasp-like parasite. We suspect that some of the pupae in the soil are also being attacked. However, the overall rate of attack appears to be well below 1%.

Table 2. Attack by the seedhead fly on tansy in Flathead and Lincoln Counties, Montana. Initial release was made in 1997 in Flathead County and in 1999 in Lincoln County.

Year	Location	Number of Sites Sampled/Cover	Number of Seedheads Examined	% of Seedheads Attacked
1997	Flathead County	3 sites in open	1,804	0.01
1998	Flathead County	6 sites in open	3,580	0.36
1999	Flathead County	6 sites in open	3,379	1.04
2000	Flathead County	4 sites in open	1,805	5.82
2001	Flathead County	4 sites in open	2,032	7.82
2000	Lincoln County	8 sites in open	6,964	1.87
2001	Lincoln County	5 sites in open	4,037	2.38

Our biggest concern with the seedhead fly is that the original colonies of insects first sent to Oregon (from which we got our supply) were from the southern coast of France and therefore the biology of this strain may not be synchronized with that of tansy in the new habitat and climate of Montana. While we have suspected that this was a problem, this is the first year we were able to test this hypothesis. By marking clusters of flower buds just before they opened (the stage at which seedhead flies lay their eggs), we were able to identify the same seedheads in the fall and check them for seedhead fly attack. We marked several hundred flower buds a week throughout the summer (late June to mid August) and were able to make an estimate of when the fly was most active (Fig. 8). While this study is preliminary and needs to be repeated, it indicates that the flies are actively laying eggs only during the first few weeks of the summer bloom. By the time the plant was in full bloom (mid July), fly activity was declining and ceased before mid-August (Fig. 9). This year, tansy continued to flower until mid-September indicating that a large number of flowers were produced after the fly's activity ceased. It is possible that as the seedhead fly population continues to increase, it may become more effective and attack may continue later into the summer. However, if the seedhead fly is to be an important component of the biocontrol complex, it may be necessary to return to Europe to find a new strain of fly from interior mountainous countries that is more synchronized with the biology of tansy in Montana.

Figure 9. Percent buds attacked by seedhead fly (x-axis) and percent tansy flowers (y-axis).



Status of the Tansy Ragwort Flea Beetle (*Longitarsus jacobaeae*)

In the successful West Cost program to control tansy, the tansy flea beetle is generally considered to be the most effective of the three biological control agents. While the adult beetles feed on the leaves and do some damage, the larvae cause extensive mortality of small plants and weaken larger plants by first feeding in the leaf petioles then burrowing into the crown. In Oregon, it is unusual for an infestation of tansy to survive longer than two or three years before the flea beetle population increases to a level which destroys the stand. Initial attempts by the Oregon Department of Agriculture to establish the flea beetle in interior Oregon east of the Cascades failed. We therefore were not surprised when the flea beetles we first brought into Montana from the Willamette Valley did poorly.

In 1998, we found a population near Mt. Hood in Oregon at about 4,000 feet elevation where the climate is similar to the infested area in Montana. Studies of this Mt. Hood strain of flea beetle over the past three years have shown that the adult females begin to lay their eggs in mid-September and continue until snow pack covers the ground. The eggs overwinter in the soil and the larvae hatch the following spring and immediately begin mining into the plant. Larvae complete development by August, but the new adults remain in the soil in a resting stage until September when they emerge and mate, completing the cycle. Unlike many insects that lay all their eggs immediately after emerging, female flea beetles lay only a few eggs each day but are capable of doing so for several months. Therefore, near Mt. Hood, the delayed emergence of adults until fall combined with the early freezes and snow covers, significantly reduce the time available for the adults to lay their eggs. Accordingly, we have noticed that although the flea beetle population is well established near Mt. Hood it appears to be significantly lower than in the Willamette Valley. Here the mild, wet, warm winters allow adult flea beetles to actively lay eggs until the following March, which probably accounts for the tremendous impact it has on tansy in this area.

We now have evidence that the tansy flea beetle is established in Montana but our population remains low. Adults were collected at only five of the 30 sites where flea beetles have been released. Evidence of feeding damage on leaves indicates that we may have populations at five additional sites, but the numbers are so low that we could not collect any adults when we vacuumed 50 plants (our standard sample size). However, the fact that we are still recovering flea beetles four years after they were originally released indicates that they can survive in Montana. We believe that over time the Montana population levels will continue to build until they are comparable to those near Mt. Hood. In 2001, we made only one new release of flea beetles. 200 adults were collected from plants near Mt. Hood, brought to Montana, and released in a cage in the Little Wolf Creek area (Cover and Fig. 10).

Given the poor synchronization of the flea beetle to tansy growing in mountain areas with long snow covered winters and the low populations we observe on Mt. Hood, we do not believe that the present strain of this insect will provide the control we desire, despite its establishment in Montana. For this reason, we are continuing with our efforts to introduce a cold adapted strain of this flea beetle from the Swiss Alps.

Fig. 8. Clusters of tansy flower buds marked with blue tags to determine seasonal variation in seedhead fly activity.

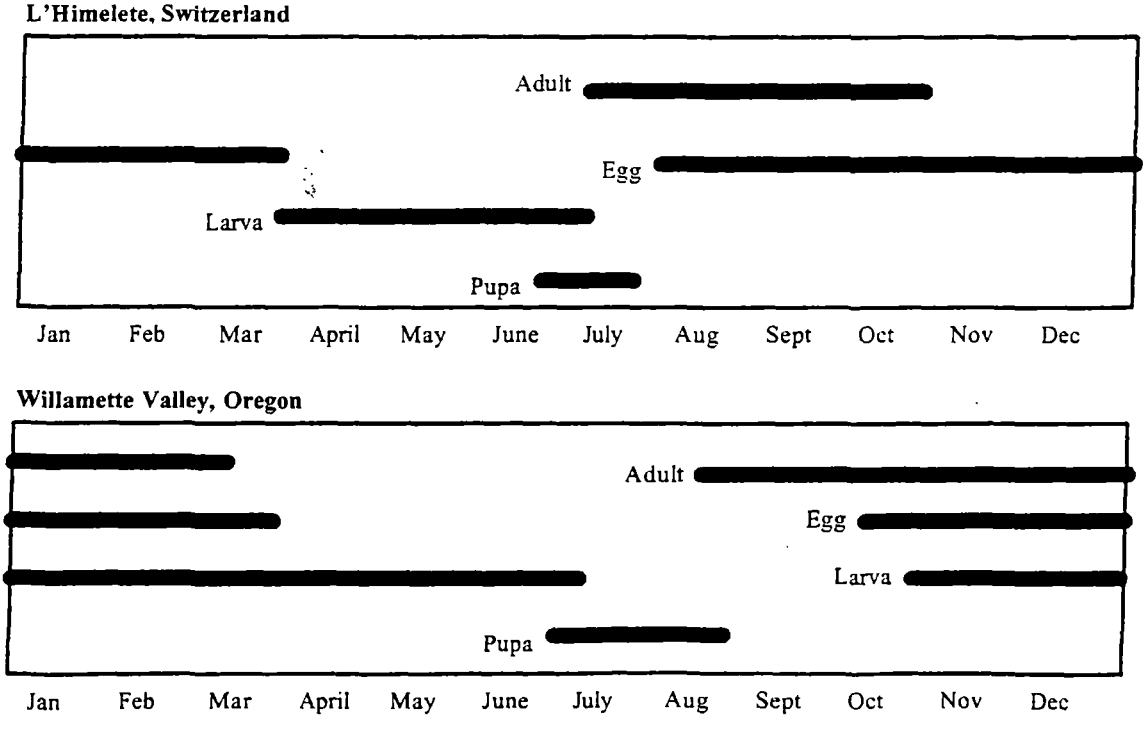
Fig. 10. In 2001, 200 fleabeetles from Mount Hood, Oregon were released in this cage in the Little Wolf Creek area of Lincoln County.

Swiss Strain of Flea Beetle (Ken Puliafico)

Ken Puliafico, an entomology graduate student supervised by Dr. Jeff Littlefield, Montana State University-Bozeman wrote the following summary of his work on the Swiss strain of flea beetle.

The tansy ragwort flea beetle (Fig. 11) has been effective in reducing tansy densities in the coastal regions of northern California, Oregon, Washington, and southern British Columbia. Unfortunately, the beetles used in the Pacific Northwest are a Mediterranean biotype and do not have a life history suitable for the continental climates of Montana. My investigations into a continental biotype started in 2000 and continued in the summer of 2001 in Switzerland where I have been working out of the CAB International Laboratory that specializes in conducting biological control research (Fig. 12). Preliminary tests under field and laboratory conditions indicate that the Swiss biotype has life history characteristics that make it better suited to the colder climates of northwestern Montana than the Willamette Valley, Oregon strains. Almost all the reproductive effort of the Swiss beetles is concentrated in the late summer and early autumn and they overwinter as eggs rather than as larvae and adults like the Oregon Willamette Valley strains (Fig. 13). In Montana, the Oregon flea beetles are just getting beginning to lay eggs when the early Montana snows start to fall. This adaptation of the Swiss strain will make it superior since it will have laid its full compliment of eggs before the early winters of northwestern Montana begin.

Figure 13. Seasonal biology of the tansy ragwort flea beetle in Switzerland and Oregon.



PLANNED 2002 WORK

1. Discontinue most of our efforts in Flathead County (other than continuing to help monitor flea beetle populations) and turn over all further redistributions, population sampling, and management of the biocontrol agents to Flathead National Forest.
2. Continue our monitoring of the biocontrol agents released in Lincoln County and continue redistribution of the cinnabar moth in the Little Wolf burn area.
3. Concentrate most of our summer's research in the Island Lake area to determine the factors preventing the establishment of the cinnabar moth, possibly putting in exclosures to keep cattle off 3-5 sites to see if this protection enhances the establishment of the moths.
4. Complete testing of the Swiss strain of the tansy flea beetle and by September prepare a petition requesting permission to release this agent in Montana.
5. Continue to support the work of Meghan Trainor, a MSU graduate student studying the invasiveness of tansy in burned areas in Montana.
6. Continue monitoring for any signs of attack by our three agents on native *Senecio* plants.

ACKNOWLEDGEMENTS

Funding for this program has come from a number of different sources. Part came from the U.S. Forest Service, Rocky Mountain Research Station's base funding for the Biological Control of Forest Weeds Program. Outside support came from the Lincoln County Weed Board which supplied us with funds from their 2001 tansy ragwort control program grant obtained from the Montana Trust Fund. Additional outside support came from the Canoe Gulch Ranger District of Kootenai National Forest from a National Fish and Wildlife Foundation "Pulling Together" grant. Funding for the MSU study on the new Swiss strain of flea beetle was provided by a Montana Trust Fund grant. Funding for the MSU tansy phenology study was provided by a U.S. Forest Service Fire Grant.

For help and support for this program, we are deeply indebted to the staffs of the Tally Lake Ranger District, Flathead National Forest and the Canoe Gulch Ranger District, Kootenai National Forest and to Tom Barbouletos of the Flathead National Forest; the Plum Creek Timber Company; and the County Weed Boards of Lincoln and Flathead Counties. For the use of Cow Camp we thank owner Terry Prongaie and ranch hands Robert and Lisa. We are also very indebted to MSU students Bessie Reneau and Travis Dubyak for doing much of the routine laboratory and field work. From MSU-Bozeman, we wish to thank graduate students Ken Puliafico and Meghan Trainor and Dr. Jeff Littlefield and Dr. Bruce Maxwell. We are grateful to insect pathologist, Elaine Oma, for her help in pathology testing. In Switzerland, we wish to thank Urs Schaffner of the CABI Bioscience Centre at Delemont for the help that he and his staff provided in finding and studying the European strain of the flea beetle. Finally, but by far not the least, we wish to thank the staff members of the Forestry Sciences Laboratory in Bozeman, Montana, particularly Kathy McDonald and Kristen Shaffer for their invaluable service in helping organize the data and prepare and print this document.

Fig. 11. Adult tansy ragwort flea beetle from Switzerland. Photo by Ken Puliafico, MSU-Bozeman.

Fig. 12. CABI Bioscience Laboratory in Delémont, Switzerland.